



Tk 30.332

1969 JUN 27

KFKI
13/1969

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BUDAPEST

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In the search of the dubious S^0 meson first found by Feldman [1] in 1965 one can utilize in a Xenon chamber experiment the γ - s emerging from the charge exchange interaction

$$\pi^+ + n \rightarrow p + X^0 \quad /1/$$

- where the unknown particle X^0 decays into four photons which may form an S^0 resonance. An experiment using this method was made by Strugalski et al [2,3] at 2.34 GeV/c. However there are a lot of channels at this energy which give a proton and two π^0 's in the final state having different effective masses. In order to use this experimental method of finding S^0 resonance one must rule out the possibility of the existence of a background channel, which could give a bump as a kinematical effect in the $\pi^0 \pi^0$ effective mass distribution at about the energy of 720 MeV. The channel in question having probably higher cross section than the S^0 at this energy is

$$\pi^+ + n \rightarrow N^{*+} + \pi^0 \rightarrow p + \pi^0 + \pi^0 \quad /2/$$

In this letter we calculate the $\pi^0 \pi^0$ effective mass distribution in the channel mentioned above. As it is experimentally and theoretically verified this process goes via ρ exchange so the Stodolsky-Sakurai model [4] can be used. Let us define a coordinate system in the rest frame of N^{*+} in a way that the x and y axis should lie in the production plane, x is along the direction of the pion directly produced in Eq. (2), the z axis is perpendicular to the production plane. In this frame of reference the effective mass squared of $\pi_1^0 \pi_2^0$ where π_1^0 denotes the pion given by the decay of N^{*+} can be easily evaluated:

$$M^2 = 2 \left(m_{\pi^0}^2 + E_{\pi_1^0} \cdot E_{\pi_2^0} - p_{\pi_1^0} \cdot p_{\pi_2^0} \sin \theta_{\pi_1} \cdot \cos \phi_{\pi_1} \right) \quad /3/$$

where $E_{\pi_1^0}, E_{\pi_2^0}, p_{\pi_1^0}, p_{\pi_2^0}$ are the energies and momenta of π_1^0 and π_2^0 , θ_{π_1} and ϕ_{π_1} are the polar and azimuthal angles. According to the Stodolsky-Sakurai model the angular distribution of π_1^0 with respect to the normal of the production plane is $f(\theta_{\pi_1}, \phi_{\pi_1}) = \frac{1}{8\pi} (1 + 3\cos^2 \theta_{\pi_1})$ [5] and therefore the effective mass distribution is given by

$$\begin{aligned} f(M) &= \frac{M}{4\pi} \int_0^{2\pi} \int_{-1}^1 \delta \left(M^2 - 2 \left(m_{\pi^0}^2 + E_{\pi_1^0} E_{\pi_2^0} - p_{\pi_1^0} p_{\pi_2^0} \sin \theta_{\pi_1} \cos \phi_{\pi_1} \right) \right) \\ &\quad \cdot (1 + 3\cos^2 \theta_{\pi_1}) d \cos \theta_{\pi_1} d \phi_{\pi_1} = \\ &= \frac{M}{16 p_{\pi_1^0} p_{\pi_2^0}} \left[5 - 3 \left(\frac{2m_{\pi^0}^2 + 2E_{\pi_1^0} E_{\pi_2^0} - M^2}{2p_{\pi_1^0} p_{\pi_2^0}} \right)^2 \right] \quad /4/ \end{aligned}$$

Comparing this and the corresponding phase-space distributions /Fig.1/ one can conclude that the $\pi^+ n \rightarrow N^{*+} \pi^0$ channel does not affect the observation of the hypothetical S^0 resonance.

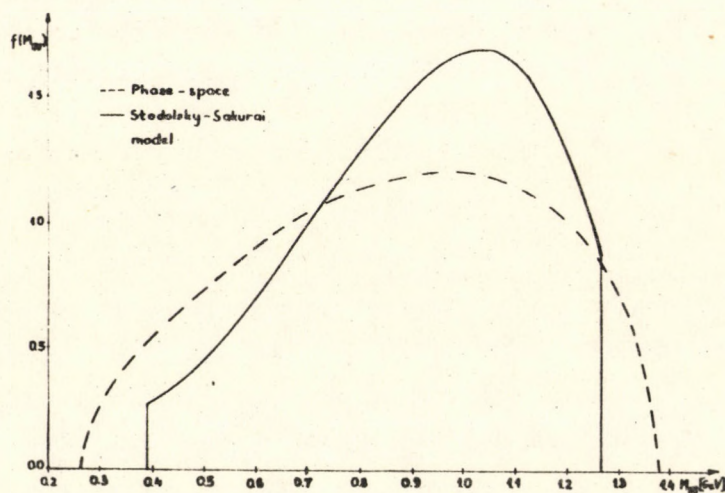


Fig. 1

The $M_{\pi^0 \pi^0}$ effective mass distribution for reaction (2) and the corresponding phase space distribution

Completing this calculation we have made a series of Monte-Carlo calculations with other kind of angular distributions which have resulted the same conclusion.

References

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Printed in the Central Research Institute for Physics, Budapest

Kiadja a Könyvtár- és Kiadói Osztály. O.v.: Dr.Farkas Istvánné

Szakmai lektor: Frenkel Andor Nyelvi lektor: Sebestyén Ákos

Példányszám: Munkaszám: 4496 Budapest, 1969. május 5.

Készült a KFKI házi sokszorosítójában. F.v.: Gyenes Imre

